# Oceanic Influence on Global Hydrological Cycle

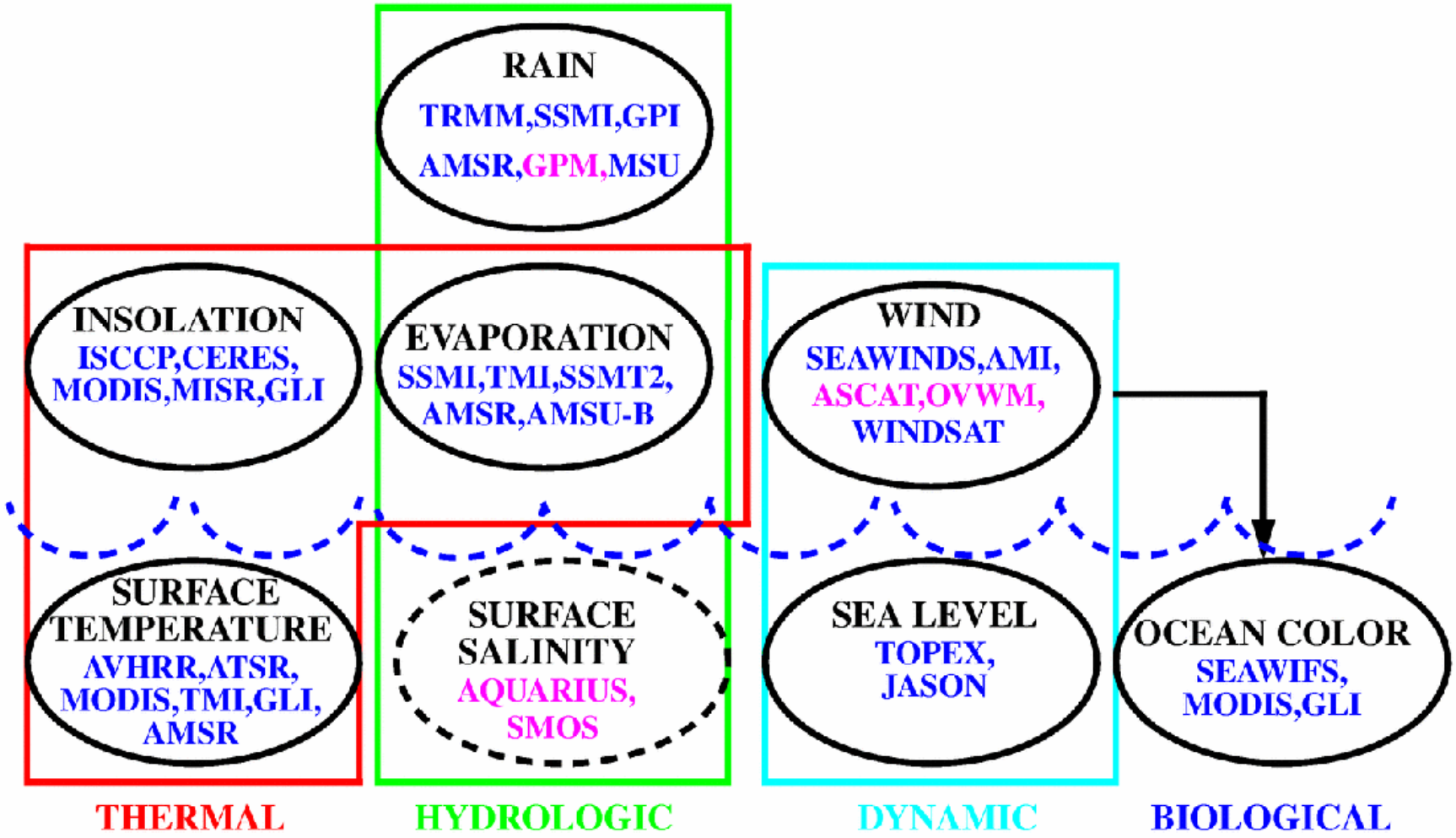
P.I. (JPL)- W. Timothy Liu
Co-Is (JPL)- Wenqing Tang & Xiaosu Xie

## Objectives

To characterize and understand the influence of ocean on terrestrial and cryospheric water cycles.

# Atmospheric Forcing and Oceanic Responses
# Synergistic Application of Spacebased Data

W. Timothy Liu / JPL



# HYDROLOGIC BALANCE

$$\frac{\partial W}{\partial t} + \nabla \bullet \Theta = E - P$$

$$\Theta = \frac{1}{g}\int_0^{p_0} qU\,\mathbf{d}p$$

$$W = \frac{1}{g}\int_0^{p_0} q\,\mathbf{d}p$$

$$\Theta = \mathbf{U_e}\, W$$

$\mathbf{U_e = U_{850mb}}$

Hecta & Mitsuta (1990)

# Components of Ocean-Atmosphere Exchanges

**(radiative)**

**SHORTWAVE RADIATION**

**LONGWAVE RADIATION**

**(turbulent)**

**SENSIBLE HEAT**

**LATENT HEAT / EVAPORATION**

**MOMENTUM**

**KINETIC ENERGY**

**PRECIPITATION**

**BULK PARAMETERIZATION FORMULAE** are used to link turbulent fluxes to mean observations

$$E = \rho C_E U (Q_S - Q)$$

$$H = \rho c C_H U (T_S - T)$$

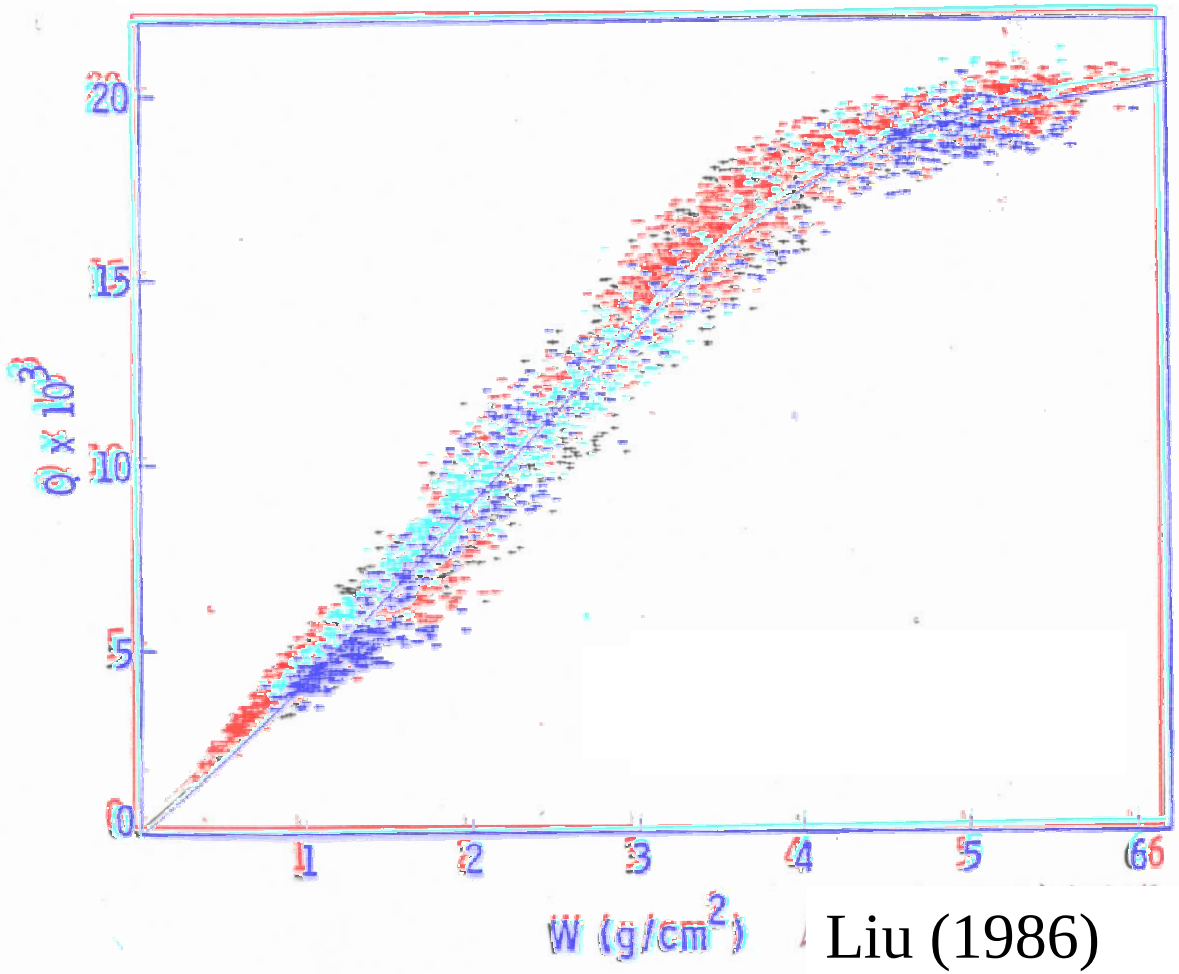
$$\tau = \rho C_D UU$$

$$K = \rho C_D U^3$$

Indian Ocean 6 stations 618 data records

S. Pacific 6 Stations 855 data records

N. Pacific 14 Stations 1992 data records

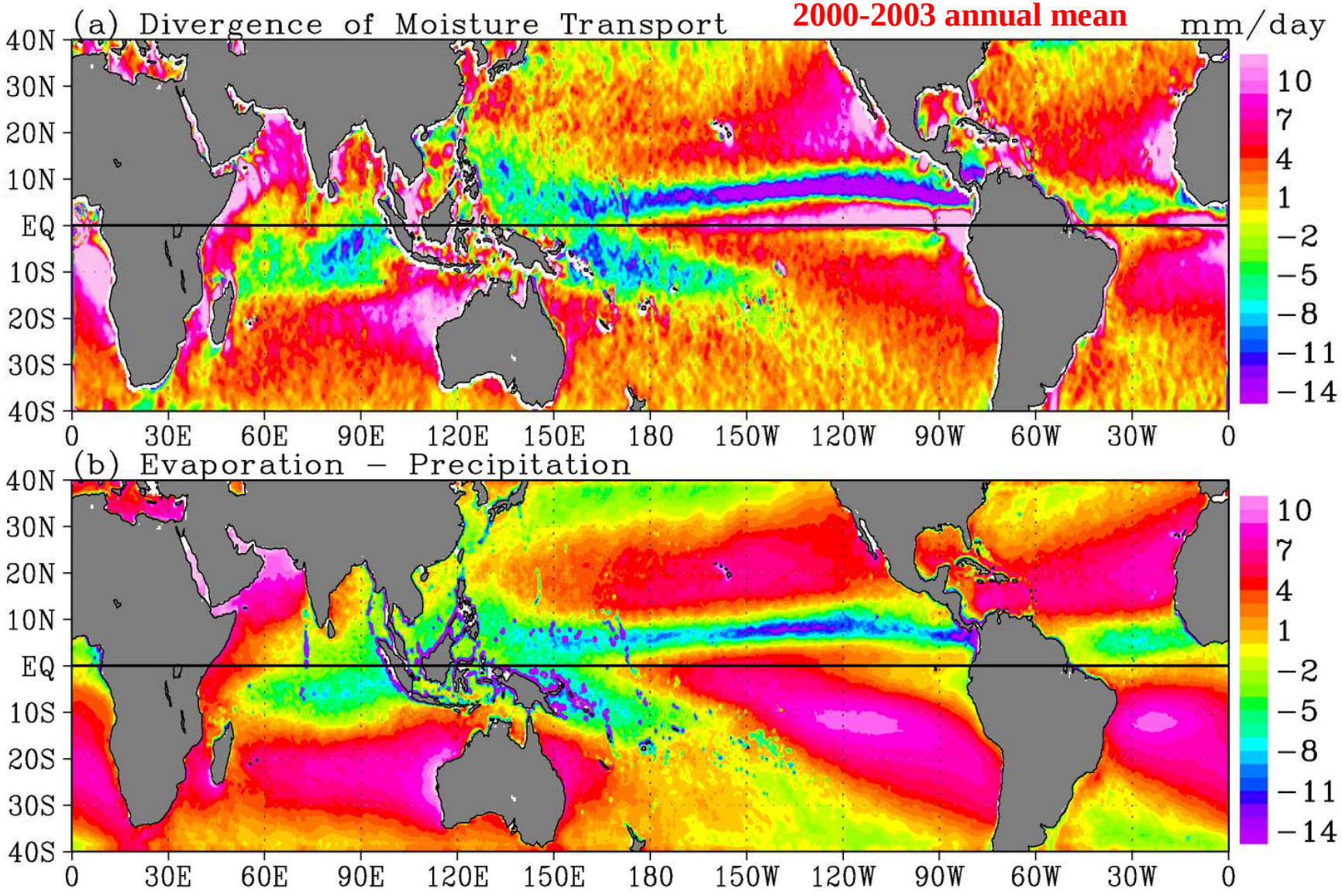



Liu (1986)

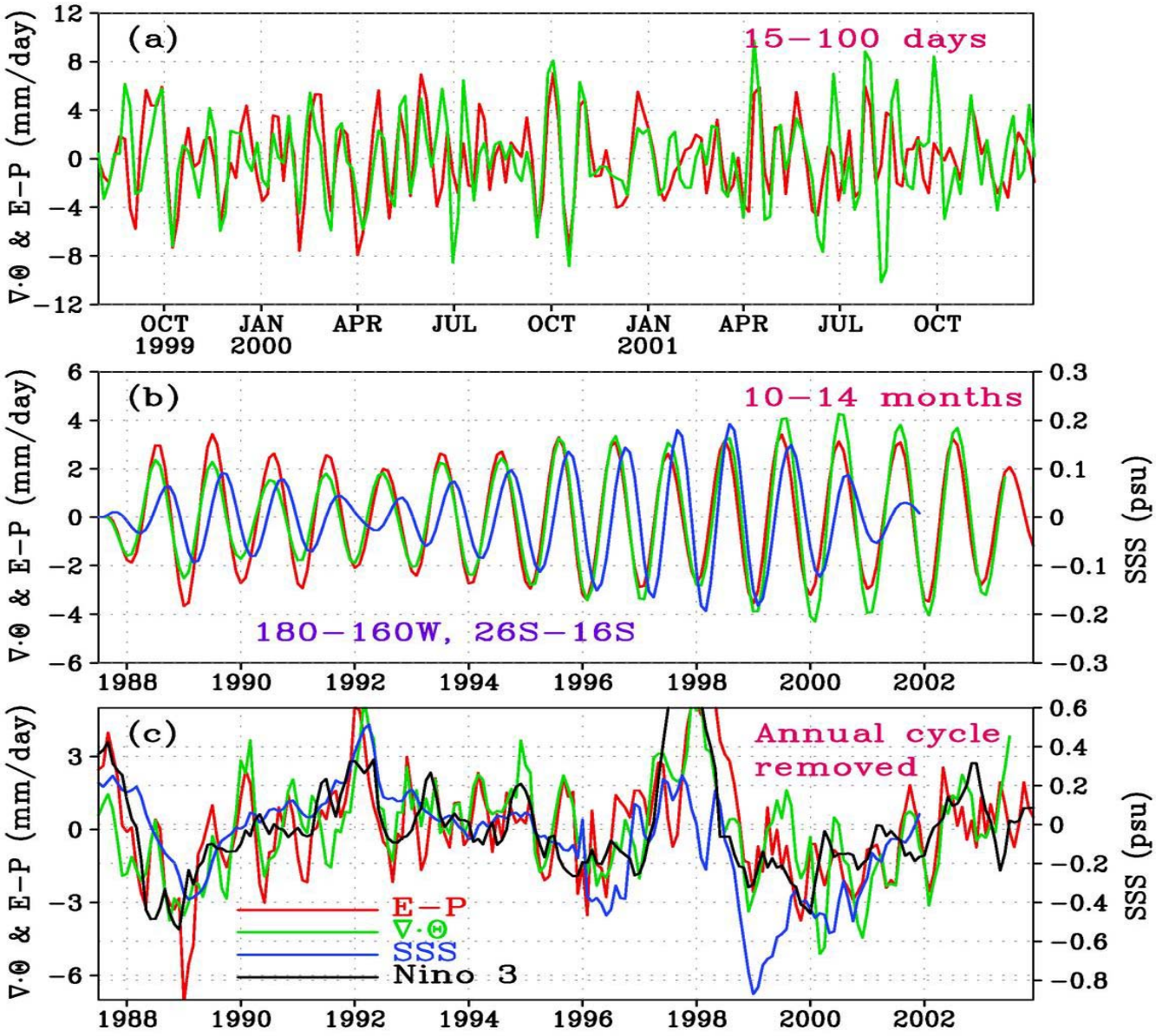
Atlantic 20 stations, 2161 data records

# Evaporation (E), precipitation (P), and moisture advection (Θ) over ocean were independently derived from space.

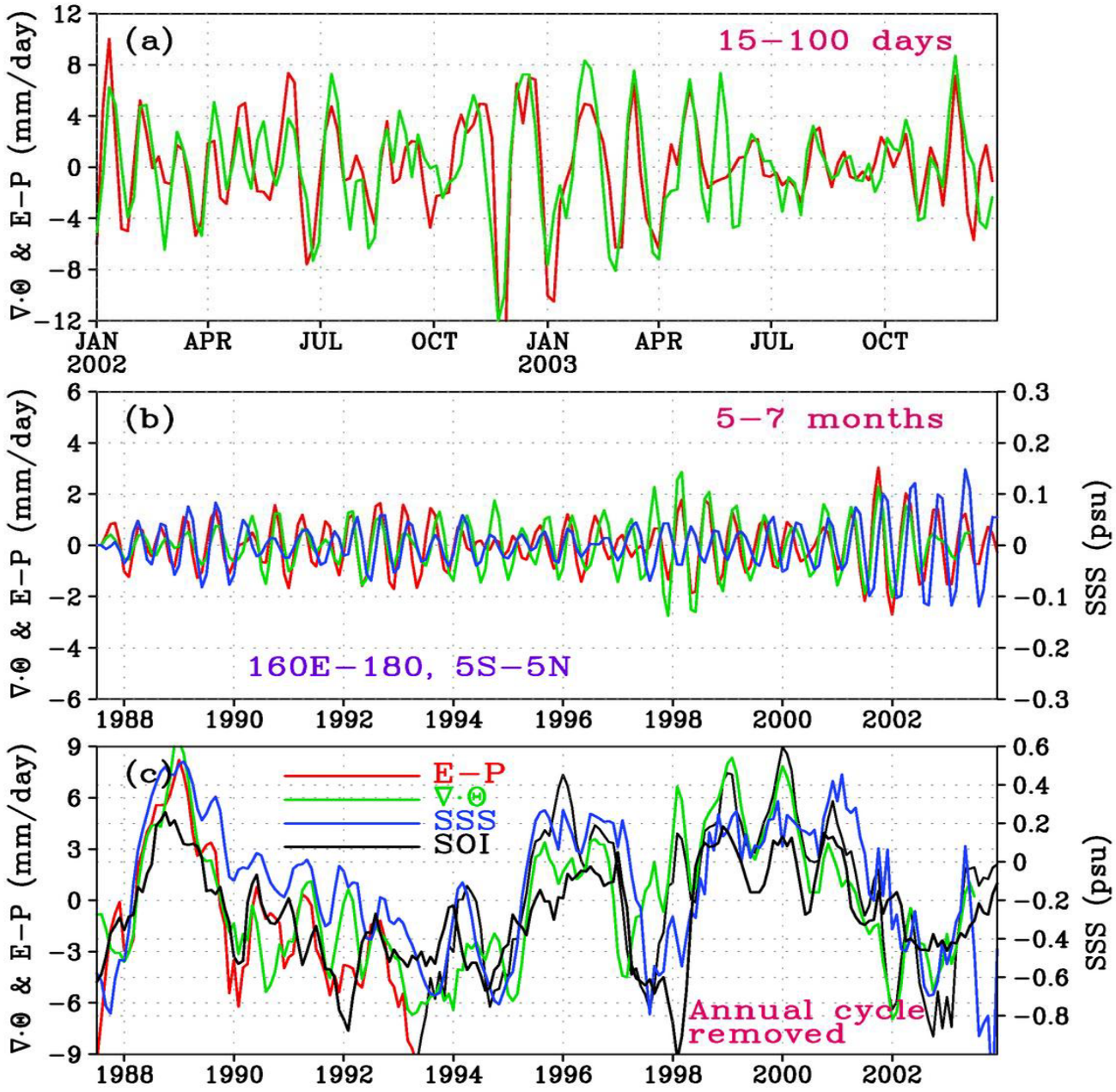
## E-P and∇·Θ show similar geographic patterns



# E-P agrees with ∇.Θ from intraseasonal to interannual time scales



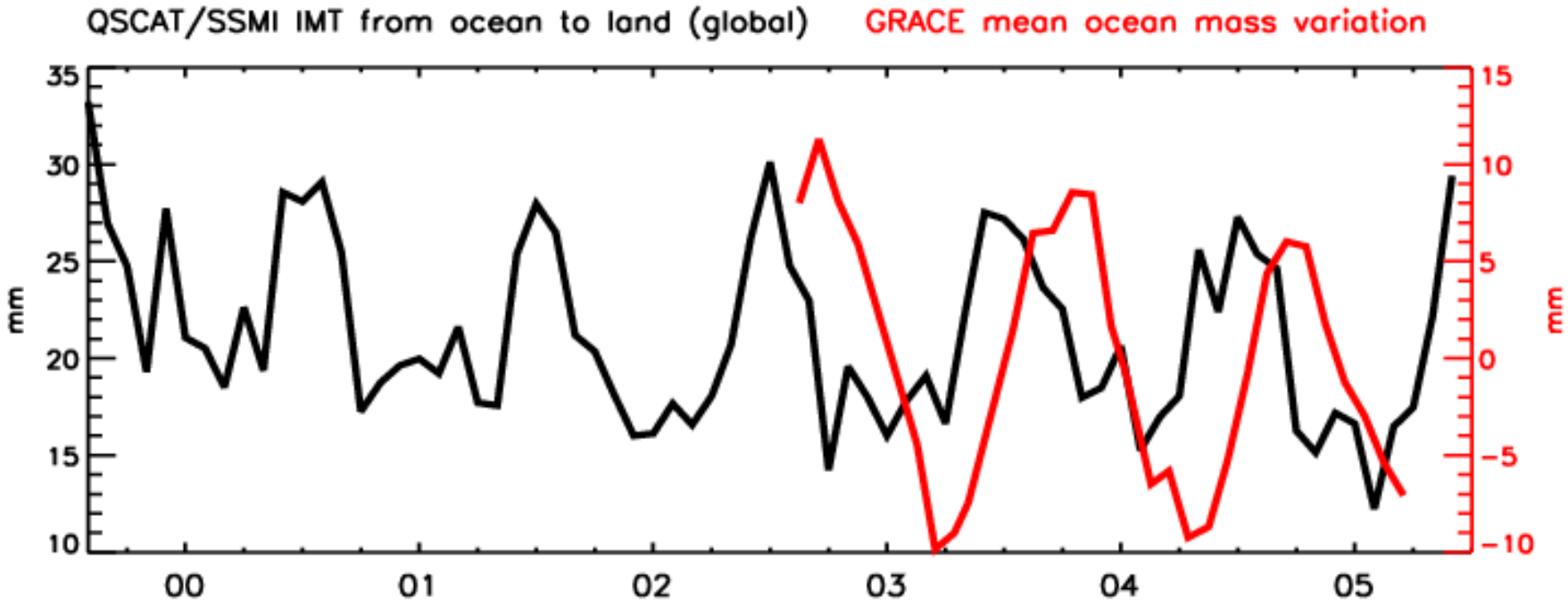

## Interannual variation strongly affected by El Nino



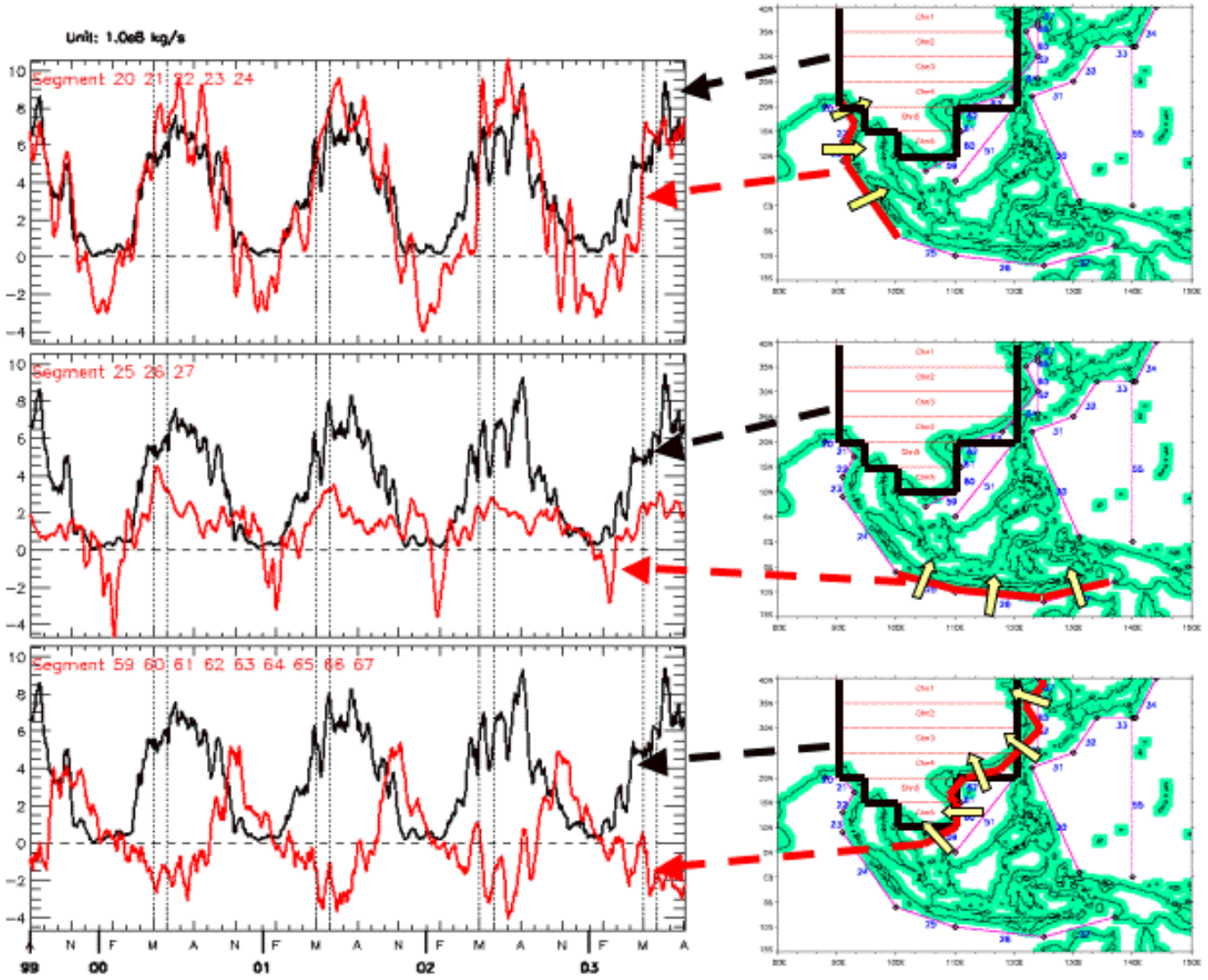

# Salinity lags hydrological forcing by 90°

**First data set we will provide:**

Moisture advection over oceans, 40°N-40°S, at daily, 0.5°resolution, starting August 1999.


QSCAT/SSMI IMT from ocean to land (global)
GRACE mean ocean mass variation
mm
mm
35
30
25
20
15
10
15
10
5
0
−5
−10
00
01
02
03
04
05

# Oceanic Influence on the precipitation in China

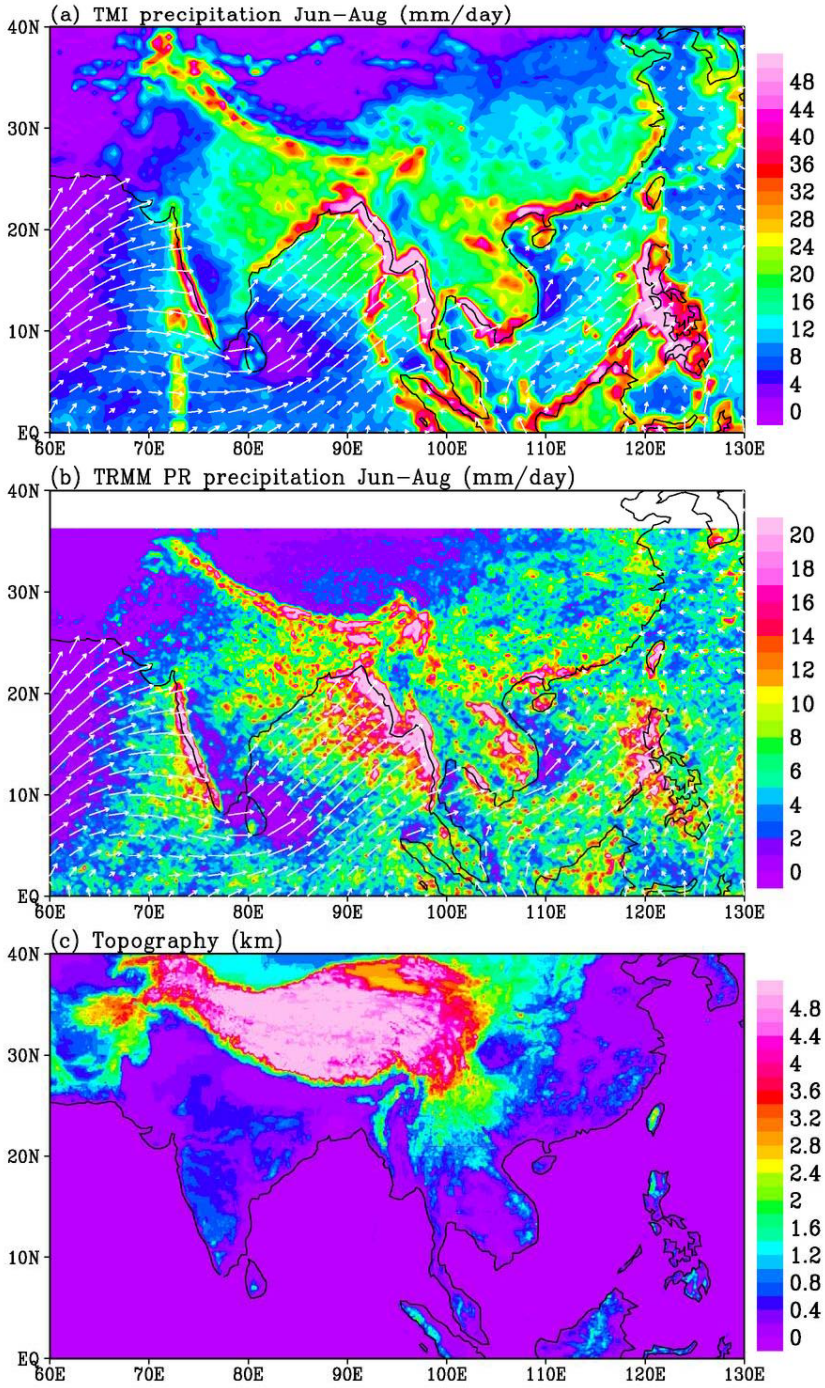



Continental rainfall increases sharply at the monsoon onset in May, and lasts until September.

Time series of precipitation integrated over east Asia agrees well with the temporal variations of moisture advected from the Bay of Bengal.

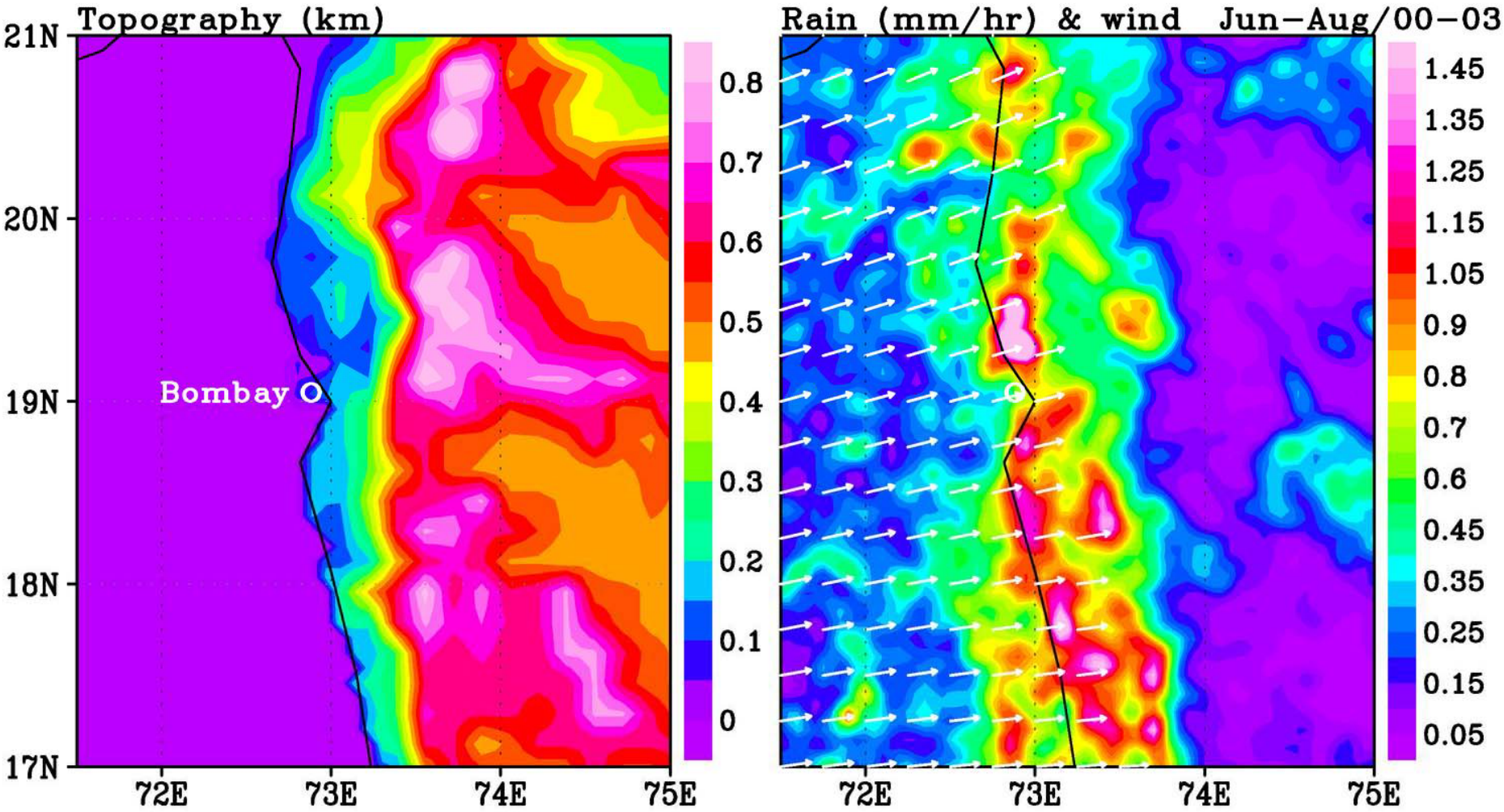
However, the sum of moisture influx from the Pacific Ocean occurs in fall, out of phase with the precipitation.

Liu, W.T. and W. Tang, 2004: Oceanic Influence on the precipitation in India and China as observed by TRMM and QuikSCAT, 2nd TRMM International Science Conference, Sept. 6-10, 2004, Nara, Japan.



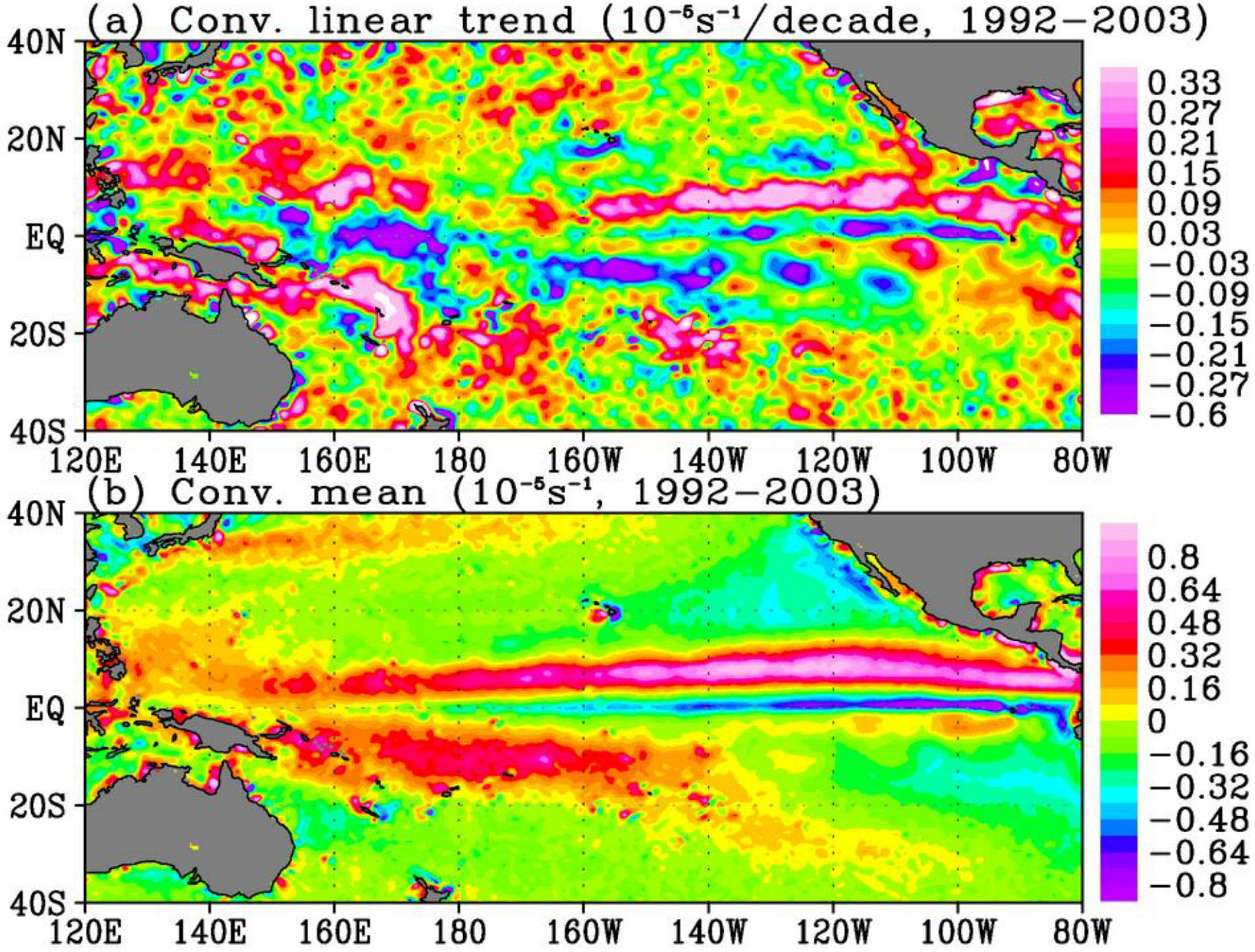

NASA ENERGY AND WATER CYCLE STUDY

NEWS




NASA ENERGY AND WATER CYCLE STUDY

NEWS


(a) Conv. linear trend ($10^{-5}s^{-1}$/decade, 1992–2003)
40N
20N
EQ
20S
40S
120E
140E
160E
180
160W
140W
120W
100W
80W
0.33
0.27
0.21
0.15
0.09
0.03
−0.03
−0.09
−0.15
−0.21
−0.27
−0.6
(b) Conv. mean ($10^{-5}s^{-1}$, 1992–2003)
40N
20N
EQ
20S
40S
120E
140E
160E
180
160W
140W
120W
100W
80W
0.8
0.64
0.48
0.32
0.16
0
−0.16
−0.32
−0.48
−0.64
−0.8

# Outside links

- OVWST
- OSTST
- PPM
- Aquarius

**Expected contribution to the NEWS objective:**

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**Issues, needs, and concerns** (to be discussed in breakouts, teaming discussions, etc.)**:**

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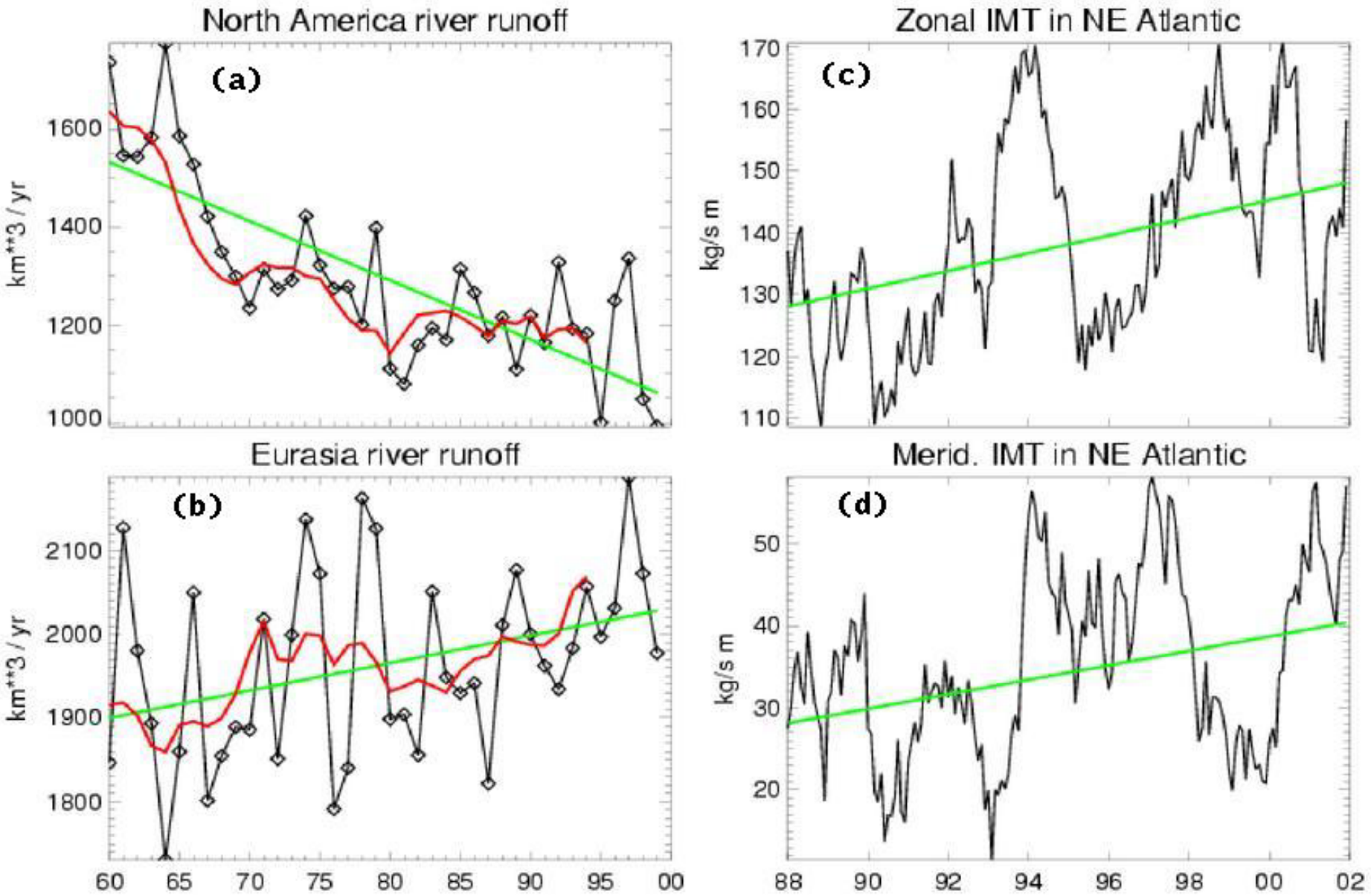
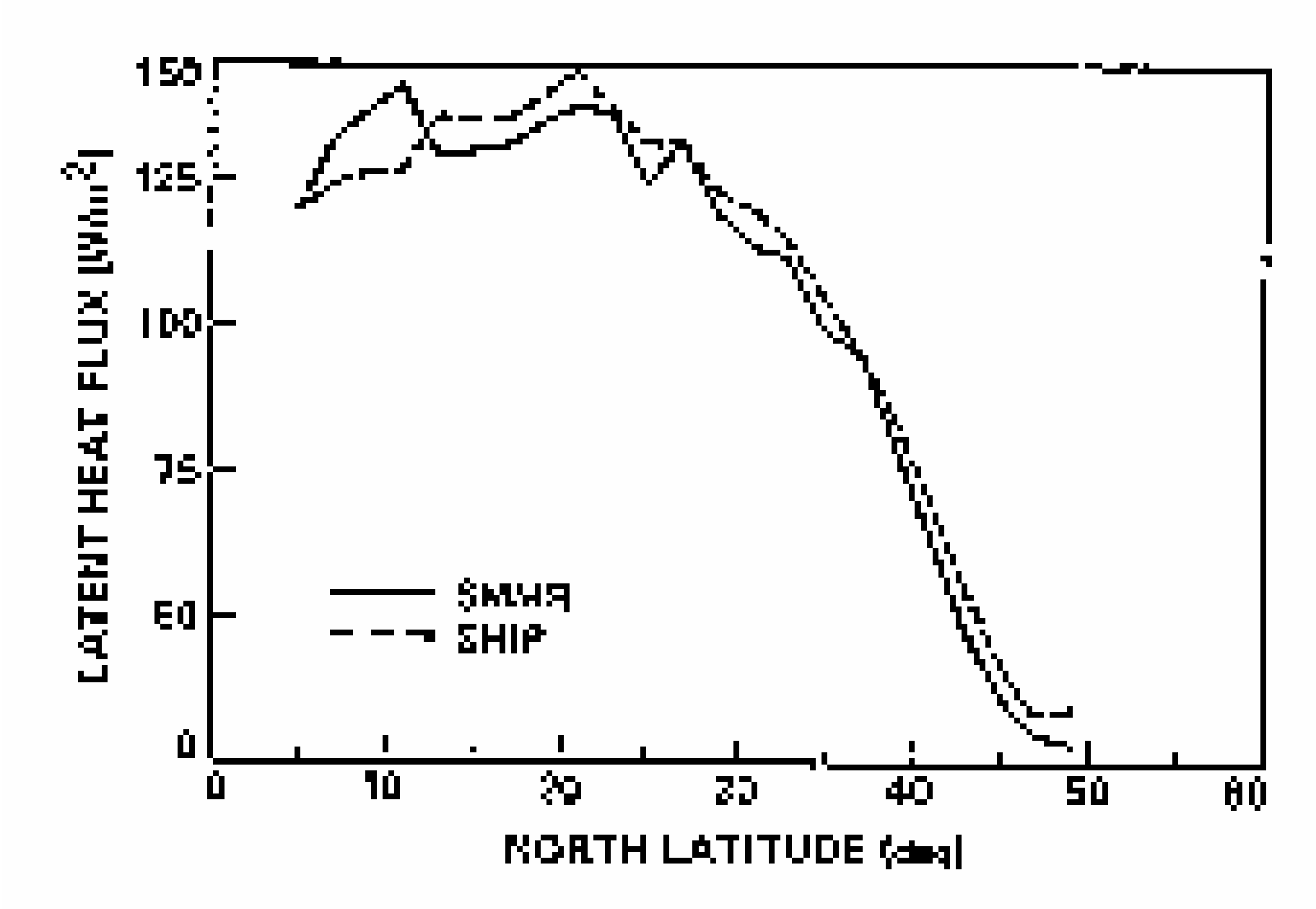

North America river runoff
(a)
km**3 / yr
1600
1400
1200
1000
Zonal IMT in NE Atlantic
(c)
kg/s m
170
160
150
140
130
120
110
Eurasia river runoff
(b)
km**3 / yr
2100
2000
1900
1800
60
65
70
75
80
85
90
95
00
Merid. IMT in NE Atlantic
(d)
kg/s m
50
40
30
20
88
90
92
94
96
98
00
02


150
125
100
75
50
0
LATENT HEAT FLUX [W/m2]
SMLWR
SHIP
0
10
20
30
40
50
60
NORTH LATITUDE [deg]